

particles are obtained after ultrasonic irradiation treatment or mechanical shear stress treatment with a homogenizer, and a mean particle size of said composite particles is not greater than 1  $\mu\text{m}$ .

wherein said polymer particles have at least one functional group selected from the group consisting of cation-formable nitrogen-containing groups and cations of cation-formable nitrogen-containing groups, and said inorganic particles are selected from the group consisting of silica, zirconia and titania.

#### REMARKS

Claims 40-43 and 81-100 are active in the present application. Claims 61-80 have been cancelled. Claims 81-100 are currently under active prosecution. Claims 40-43 are non-elected claims. Support for new Claims 81-100 is found in Claims 61-80. No new matter has been added.

#### REQUEST FOR RECONSIDERATION

Applicants thank Examiner Deo and the Examiner's Supervisor Mr. Ben Utech for the helpful and courteous discussion of May 21, 2003. During the discussion, Applicants' U.S. representative presented arguments supporting the patentability of the presently claimed invention in view of the prior art cited by the Examiner. The obviousness of the claimed invention was traversed on the grounds that the primary reference (Ronay) cited in the obviousness rejection (1) does not disclose the functionalized polymer particles presently claimed, (2) teaches that the combination of the prior art polyelectrolyte and abrasive particle inhibits the polishing rate, contradictory to the result observed for the claimed invention, and (3) a side-by-side comparison of the prior art slurry with the claimed dispersion demonstrates

that the claimed dispersion provides properties such as increased polishing rate that would not be expected from the prior art combination of a polymer and inorganic particle.

Claims 61-80 have been cancelled and replaced with new Claims 81-100. The new claims have been added so that there is no repetition of claim numbering with respect to any prior filed amendments. New Claims 81-100 correspond with Claims 61-80. Claim 93 is now dependent from Claim 90.

The claimed invention is drawn to a "dispersion comprising polymer particles, inorganic particles and water..." (see present independent claims). The polymer particles of the presently claimed invention are dispersed in a water-containing mixture. As supported by the dictionary definition attached herewith, the chemical usage of the term "dispersion" is "[a] distribution of finely divided particles in a medium" (see Dictionary of Science and Technical Terms, 5th ed., S.P. Parker, Ed., McGraw-Hill, Inc. (1994), p. 592 - see copy attached herewith). Particles dispersed in a medium are not dissolved in the medium. A substance dissolved in a medium is a solute (e.g., "[t]he substance dissolved in a solvent"; Dictionary of Science and Technical Terms, 5th ed., S.P. Parker, Ed., McGraw-Hill, Inc. (1994), p. 1865 - see copy attached herewith).

Therefore, the presently claimed invention requires the presence of dispersed (not dissolved) polymer particles where the polymer has a carboxyl or sulfonic acid functional group. The presently claimed invention further requires that each polymer particle is attached to a plurality of inorganic particles.

Applicants traverse the Office's assertion that the present claims are obvious in view of a patent to Ronay (U.S. 5,876,490). The Office appears to base its assertion that the claimed invention is obvious at least in part on the disclosure of the last paragraph of column 7 of Ronay. The relevant passage is reproduced below for convenience:

According to an alternative embodiment, non water-soluble polymers can be employed as the non-polishing

particles in place or in addition to the polyelectrolyte-coated abrasive particles. Suitable synthetic organic polymers include polystyrene, butadiene rubbers and water-dispersible polyurethane powders. The polymers are in the form of submicron powder particles. If desired, the polymer particles can be treated with a surfactant such as sodium laurel sulfate, to render them hydrophilic (col. 7, lines 59-66).

The prior art non water-soluble polymer is a material such as polystyrene, butadiene rubber or a water dispersible polyurethane powder. The presently claimed invention requires that the polymer particle have at least one functional group such as a carboxyl group or a sulfonic acid group (see present independent Claims 81, 90, 99 and 100). The non water-soluble polymer disclosed in column 7 of Ronay is nowhere described to contain such a functional group. Although the prior art non water-soluble polymer particle may be rendered hydrophilic by treatment with a surfactant, nowhere is it disclosed or suggested that the resulting polymer/surfactant mixture would contain a polymer having a functional group such as a carboxyl or sulfonic acid group. The non water-soluble polymer of Ronay cannot be the polymer particle presently claimed since it does not have functional groups.

The Office also appears to base its determination of obviousness on the disclosure that the nonwater-soluble polymer of Ronay may be submicron in size. It is not relevant that the non water-soluble polymer particle of Ronay may be present in the form of submicron particles because this polymer is not the polymer particle presently claimed. Moreover, it does not matter that the Ronay patent may describe slurries wherein the ratio of the size of the polymer particle to the size of the abrasive particle falls within or encompasses the presently claimed polymer particle/abrasive particle size ratio ( $Sp/Si = 1-40$ ) since the prior art polymer particle is not the presently claimed polymer particle.

The slurries of Ronay are nowhere disclosed to contain dispersed polymer particles having the presently claimed functional groups. Instead, Ronay discloses the inclusion of a polyelectrolyte in the prior art compositions.

The non water-soluble polymer described in Ronay is not the polyelectrolyte described elsewhere in the reference nor is it the polymer particle presently claimed. This polymer is different from the prior art polyelectrolyte which is described as “[u]nlike most uncharged polymers, polyelectrolytes usually are soluble in polar solvents. (e.g. water)” (col. 5, lines 3-5). The Examples of Ronay describe the addition of a solution of the prior art polyelectrolyte to an aqueous suspension of abrasive particles thus demonstrating that the prior art electrolyte is not the non water-soluble polymer described elsewhere in Ronay (column 9, lines 13-15).

The polyelectrolyte of Ronay is different from the polymer particle presently claimed. Throughout the Ronay patent it is disclosed that the prior art polyelectrolytes (polyions) adsorb onto the abrasive particles (col. 2, lines 23-25; col. 3, lines 35-38; col. 3, lines 43-46; col. 5, lines 11-13; and col. 9, lines 17-19). Adsorption is a process wherein molecules from a first phase are concentrated on or in a second immiscible phase (see Concise Encyclopedia of Science and Technology, 3<sup>rd</sup> ed., S.P. Parker, Ed., McGraw-Hill, Inc. (1994), p. 47 copy attached herewith for convenience). Ronay describes a slurry that is formed when a soluble polyelectrolyte is mixed with an immiscible solid phase (abrasive particle). Thus, the polyelectrolyte is in a liquid phase (solvent such as water) and is present in solution in the solvent medium whereas the polymer of the presently claimed invention is a polymer particle present in the form of particles dispersed in an aqueous medium (page 6, last paragraph and paragraph bridging pages 7 and 8). Once the prior art polyelectrolyte has coated the prior art abrasive, the resulting particle is not a polymer particle but rather a coated abrasive particle.

Therefore, the polyelectrolyte of Ronay is different from the presently claimed polymer particle. A water soluble polyelectrolyte cannot render obvious a polymer particle containing functional groups.

The presently claimed invention also requires that a plurality of inorganic particles is attached to the surface of each of the polymer particles present in the claimed dispersion. In paragraph 2 on page 2 of the Office Action of April 30, 2003, the Office states that the Ronay reference “claims a plurality of inorganic particles are attached to a surface of polymer particles (col. 3, lines 40-43; col. 4, lines 55-65).” Applicants note that nowhere at column 3, lines 40-43 or column 4, lines 55-65 of Ronay, is it disclosed that a plurality of inorganic particles are attached to the surface of the polymer particle.

The presently claimed invention requires that carboxyl or sulfonic acid group-containing polymer particles are dispersed in a water-containing mixture. The presently claimed invention cannot be obvious in view of Ronay since Ronay does not disclose or suggest a dispersion of polymer particles having an aqueous carboxyl or sulfonic acid functional groups.

The claimed invention is further unobvious over Ronay as evidenced by Applicants' demonstration of the significant superiority of the claimed dispersions over the prior art slurries in a side-by-side comparison with the closest prior art. Applicants submitted a Declaration with the Amendment and Request for Reconsideration filed with the Office on March 14, 2003, providing evidence that the presently claimed invention provides a significantly superior polishing performance in comparison to the closest prior art (copy of the Declaration is attached herewith for convenience). The Declaration compares the polishing rate of a dispersion meeting the present claim limitations against an alumina particle dispersion and the prior art dispersion. The results of this comparison are tabulated below for convenience.

	Polishing Rate	Number of scratches
Present dispersion Example 2A (Sp/Si=1.3)	<b>3,900 Å/min</b>	30 pts
(i) Alumina particles (no polymer particle)	1,300 Å/min	85 pts
(ii) Ronay slurry	410 Å/min	200 pts

Boxed row represents inventive Example.

It is immediately evident from the table above that the polishing rate and scratch performance of a dispersion meeting the present claim limitations is significantly superior to that obtained for either of a dispersion containing only alumina particles or the prior art polyelectrolyte/abrasive dispersion.

The polishing rate exhibited by the claimed dispersion is nearly twice the polishing rate exhibited by a dispersion containing only alumina particles, and nearly ten times the rate of the prior art dispersion. The fact that the claimed dispersion is able to provide such improved polishing rate makes sense in view of the fact that Ronay discloses that the prior art polyelectrolyte/abrasive dispersion acts to inhibit polishing.

A comparison of the presently claimed aqueous dispersion against a Ronay slurry containing a non water-soluble particle polymer (the prior art polymer particle and its differences with the presently claimed polymer particle are described at length above) is presented on page 5 of the Declaration. The results are tabulated below for convenience.

Table 2

	Polishing Rate	Number of scratches
Using polymer particle (a) : JSR method	3,900 Å/min	30 pts
Using polymer particle (R1); Ronay method	650 Å/min	65 pts
Alumina particles (no polymer particle)	1,900 Å/min	85 pts

Boxed row represents inventive Example.

As is readily evident from Table 2 above, a dispersion which contains the prior art non water-soluble polymer particle (which does not contain a carboxyl or sulfonic acid group) is unable to provide the polishing performance of the presently claimed invention. In fact, the polishing rate exhibited by the Ronay non water-soluble containing dispersion is 80% less than that observed for the claimed invention.

Applicants submit the evidence provided in the Declaration dated January 28, 2003, demonstrates that the claimed aqueous dispersion which contains polymer particles and abrasive particles is able to provide significantly superior polishing rate and scratch performance in comparison to the prior art slurry. The Declaration is sufficient for evidencing that:

"[t]he polishing rate for the presently claim composition would not be expected from the disclosure of the Ronay specification which discloses an inhibitory effect for polishing rate when a polymer particle and an inorganic particle are combined in a polishing slurry" (page 4 of the Declaration).

As such, the Declaration is effective in providing a showing that dispersions containing particulate polymer and abrasive particles are significantly superior to the prior art slurries wherein the polyelectrolyte is in solution and coats the abrasive particle.

The presently claimed invention cannot be obvious in view of the showing (Declaration dated of January 28, 2003) that the claimed invention provides polishing performance that would not be expected from the prior art disclosure.

The claimed invention is further unobvious in view of Ronay in view of the contradictory teachings of the prior art reference. Ronay specifically teaches that the combination of the prior art polyelectrolyte and prior art abrasive particle results in decreased polishing rate. As was demonstrated by the data submitted as part of the declaration, the claimed combination of polymer particles and inorganic particles provides an increased polishing rate. The disclosure that the prior art slurries provide reduced polishing rate is repeated throughout Ronay, for example:

Among the aspects recognized by the present inventor about poly-coated abrasive particles are the following:

1. Their polishing action is greatly reduced, which results in diminishing polishing rates (col. 3, lines 49-54).
2. The polymer-coated particles accumulate in the recesses of the pattern and since they have hardly any polishing action, the polish rate in the recesses is very slow (col. 4, lines 15-18).

Ronay therefore contains an express teaching that the combination of the prior art polyelectrolyte and abrasive results in reduced polishing rates. In comparison, and as demonstrated above, the claimed invention provides an increased polishing rate.

The presently claimed invention is further unobvious in view of Ronay given the difference in the structure of the presently claimed dispersion, which contains a polymer particle/abrasive particle aggregate in comparison to the coated particle of Ronay. In the claimed invention, each polymer particle is attached to a plurality of inorganic particles (abrasive particles). In contrast, the polyelectrolyte of Ronay coats the abrasive particles of the prior art slurry (col. 2, lines 62-65; col. 3, lines 43-46; col. 4, lines 1-4; col. 7, lines 46-52; and Fig. 3). The structure of the prior art polyelectrolyte/abrasive composite is the inverse of

the claimed polymer particle/inorganic particle dispersion. Applicants submit that the coated abrasive structure obtained by absorbing a polyelectrolyte onto an abrasive surface cannot render obvious the mixture of polymer particles and abrasive particles presently claimed.

Applicants submit the presently claimed invention is not obvious in view of the prior art references relied upon by the Examiner. Applicants respectfully request the withdrawal of the rejection under 35 U.S.C. § 103(a) and passage of all now-pending claims to Issue.

Respectfully Submitted,

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IN THE CLAIMS

Claims 61-80. (Cancelled).

Claims 81-100 (New).

# **McGRAW-HILL DICTIONARY OF SCIENTIFIC AND TECHNICAL TERMS**

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**dispersal pattern** [GEOCHEM] Distribution pattern of metals in soil, rock, water, or vegetation. {də'spərsəl, pad'əm}

**dispersant** [MATER] Also known as dispersing agent. 1. An additive that can hold finely ground materials in suspension; used as a thinning agent for a slurry. 2. A material added to a paste, mortar, or concrete to improve the flow properties. {di'spərənt}

**disperse** [COMPUT SCI] A data-processing operation in which grouped input items are distributed among a larger number of groups in the output. {də'spərs}

**dispersed elements** [GEOCHEM] Elements which form few or no independent minerals but are present as minor ingredients in minerals of abundant elements. {də'spərst' ēl'əmənts}

**dispersed gas injection** [PETRO ENG] Gas-injection pressure maintenance of an oil reservoir in which the injection wells are arranged geometrically to distribute the gas uniformly throughout the oil-productive portions of the reservoir. {də'spərst'gas in'jek'shən}

**disperse dye** [MATER] A very slightly water-soluble, colored material for use on cellulose acetate and other synthetic fibers; color is transferred to the fiber as extremely finely divided particles, resulting in a solution of the dye in the solid fiber. {də'spərs, dī}

**disperse phase** [CHEM] The phase of a disperse system consisting of particles or droplets of one substance distributed through another system. Also known as discontinuous phase; internal phase. {də'spərs, fāz}

**disperser** [MATER] Material added to solid-in-liquid or liquid-in-liquid suspensions to separate the individual suspended particles; used in pigment grinding and dye dispersion. Also known as dispersing agent; emulsifier; emulsifying agent. {də'spərsər}

**disperse system** [CHEM] A two-phase system consisting of a dispersion medium and a disperse phase. {də'spərs, sis'təm}

**dispersible inhibitor** [CHEM] An additive that can be dispersed in a liquid with only moderate agitation to retard undesirable chemical action. {dī'spərsə-bal in'hib'ētər}

**dispersing agent** See dispersant, disperser. {də'spərs'ēn, ā-jənt}

**dispersing prism** [OPTICS] An optical prism which deviates light of different wavelengths by different amounts and can therefore be used to separate white light into its monochromatic parts. {də'spərs'ēn, priz'm}

**dispersion** [AERO ENG] Deviation from a prescribed flight path; specifically, circular dispersion especially as applied to missiles. [ASTRON] The frequency dependence of the retardation of radio waves (such as those emitted by a pulsar) when they pass through an ionized gas. [CHEM] A distribution of finely divided particles in a medium. [COMMUN] The entropy of the output of a communications channel when the input is known. [ELECTROMAG] Scattering of microwave radiation by an obstruction. [MINERAL] In optical mineralogy, the constant optical values at different positions on the spectrum. [PHYS]

1. The separation of a complex of electromagnetic or sound waves into its various frequency components. 2. Quantitatively, the rate of change of refractive index with wavelength or frequency at a given wavelength or frequency. 3. The rate of change of deviation with wavelength or frequency. 4. In general, any process separating radiation into components having different frequencies, energies, velocities, or other characteristics, such as the sorting of electrons according to velocity in a magnetic field. [STAT] The degree of spread shown by observations in a sample or a population. {də'spərzhən}

**dispersion equation** See dispersion formula. {də'spərzhən i'kwāzhən}

**dispersion error** [ORD] Chance variation in a series of shots even though firing conditions are kept as constant as possible. {də'spərzhən, ēr-ər}

**dispersion force** [PHYS CHEM] The force of attraction that exists between molecules that have no permanent dipole. {də'spərzhən, fōrs}

**dispersion formula** [PHYS] Any formula which gives the refractive index as a function of wavelength of electromagnetic radiation. Also known as dispersion equation. {də'spərzhən, fōrmyələ}

**dispersion fuel** [NUCLEO] A fuel mixture consisting of a nuclear fuel dispersed in a nonfissionable matrix. {də'spərzhən, fyūl}

**dispersion index** [STAT] Statistics used to determine the homogeneity of a set of samples. {dī'spərzhən, īn'deks}

**dispersion ladder** [ORD] Table showing the probable distribution of a succession of shots made with the same firing data; specifically, a diagram made up of eight zones, showing the percentage of shots which may be expected to fall within each zone, based on direction (deflection) or range. {də'spərzhən, lād'ər}

**dispersion measure** [ASTRON] A quantity that describes the dispersion of a radio signal, proportional to the product of the density of interstellar electrons and the distance to the source. {də'spərzhən, mez'hər}

**dispersion medium** See continuous phase. {də'spərzhən, mēd'ēəm}

**dispersion mill** [MECH ENG] Size-reduction apparatus that disrupts clusters or agglomerates of solids, rather than breaking down individual particles; used for paint pigments, food products, and cosmetics. {də'spərzhən, mil}

**dispersion pattern** [ORD] The distribution of a series of shots by using coordinate settings as nearly identical as possible. {də'spərzhən, pad'əm}

**dispersion relation** [NUC PHYS] A relation between the cross section for a given effect and the de Broglie wavelength of the incident particle, which is similar to a classical dispersion formula. [PHYS] An integral formula relating the real and imaginary parts of some function of frequency or energy, such as a refractive index or scattering amplitude, based on the causality principle and the Cauchy integral formula. [PL PHYS] A relation between the radian frequency and the wave vector of a wave motion or instability in a plasma. {dō'spərzhən ri, läshən}

**dispersion strengthening** [SOLID STATE] The reduction of plastic deformation of a solid by the presence of a uniform dispersion of another substance which inhibits the motion of plastic dislocations. {də'spərzhən, streng'k'ħənīŋ}

**dispersion zone** [ORD] The area over which shots scatter when fired with the same sight setting. {də'spərzhən, zōn}

**dispersive line** [ELECTROMAG]. A delay line that delays each frequency a different length of time. {də'spərsiv 'lin}

**dispersive medium** [ELECTROMAG] A medium in which the phase velocity of an electromagnetic wave is a function of frequency. {də'spərsiv 'mēdēəm}

**dispersive power** [OPTICS] A measure of the power of a medium to separate different colors of light, equal to  $(n_2 - n_1)/(n - 1)$ , where  $n_1$  and  $n_2$  are the indices of refraction at two specified widely differing wavelengths, and  $n$  is the index of refraction for the average of these wavelengths, or for the D line of sodium. {də'spərsiv, pāū'ər}

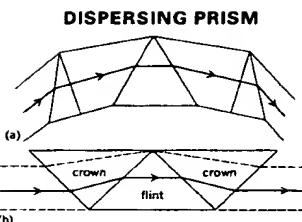
**dispersoid** [CHEM] Matter in a form produced by a disperse system. {də'spər, sōid}

**dispinohedron** [CRYSTAL] 1. A crystal form with four similar triangular faces combined in a wedge shape; can be tetragonal or orthorhombic. 2. A crystal form with eight scalene triangles combined in pairs. {dī'sfē,nōid}

**displaced ore body** [GEOL] An ore body which has been subjected to displacement or disruption after its initial deposition. {dis'plāst'ōr, bād'ē}

**displacement** [CHEM] A chemical reaction in which an atom, radical, or molecule displaces and sets free an element of a compound. [COMPUT SCI] The number of character positions or memory locations from some point of reference to a specified character or data item. Also known as offset. [ELEC] See electric displacement. [FL MECH] 1. The weight of fluid which is displaced by a floating body, equal to the weight of the body and its contents; the displacement of a ship is generally measured in long tons (1 long ton = 2240 pounds). 2. The volume of fluid which is displaced by a floating body. [GEOL] See dislocation. [MECH] 1. The linear distance from the initial to the final position of an object moved from one place to another, regardless of the length of path followed. 2. The distance of an oscillating particle from its equilibrium position. [MECH ENG] The volume swept out in one stroke by a piston moving in a cylinder as for an engine, pump, or compressor. [PSYCH] A defense mechanism in which emotions, ideas, or wishes are transferred from their original object to a more acceptable substitute. {dis'plās'mēnt}

**displacement angle** [ELEC] The change in the phase of an alternator's terminal voltage when a load is applied. {dis'plās'mēnt, ānj'gəl}



Two types of dispersing prisms.  
(a) Rayleigh prism system.  
(b) Amici direct-vision system  
consisting of flint-glass prism and  
two crown-glass prisms.

**valley-restricted benches** developed at the same elevation in proximate valleys, and which would produce a pediment if uninterrupted planation were to continue at this level. ( 'pärshəl 'ped-mənt )

**partial penetration** [ORD] Penetration obtained when a projectile fails to pass through the target far enough for either the projectile itself or light from its penetration to be seen from the back of the target. ( 'pärshəl ,pen-ə'trə-shən )

**partial plane** [MATH] In projective geometry, a plane in which at most one line passes through any two points. ( 'pärshəl 'plān )

**partial pluton** [GEOL] That part of a composite intrusion representing a single intrusive episode. ( 'pärshəl 'plü-tən )

**partial potential temperature** [METEOROL] The temperature that the dry-air component of an air parcel would attain if its actual partial pressure were changed to 1000 millibars ( $10^5$  pascals). ( 'pärshəl pə'ten-chəl 'tem-prə-chər )

**partial pressure** [PHYS] The pressure that would be exerted by one component of a mixture of gases if it were present alone in a container. ( 'pärshəl 'preh-ər )

**partial-pressure maintenance** [PETRO ENG] The partial replacement of produced gas in an oil reservoir by gas injection to maintain a portion of the initial reservoir pressure. ( 'pärshəl 'preh-ər ,mänt-ə-nəns )

**partial pressure suit** [AERO ENG] A skintight suit which does not completely enclose the body but which is capable of exerting pressure on the major portion of the body in order to counteract an increased oxygen pressure in the lungs. ( 'pärshəl 'preh-ər ,süt )

**partial product** [MATH] The product of a multiplicand and one digit of a multiplier that contains more than one digit. ( 'pärshəl 'präd-əkt )

**partial-read pulse** [ELECTR] Current pulse that is applied to a magnetic memory to select a specific magnetic cell for reading. ( 'pärshəl ,rēd 'pəls )

**partial regression coefficient** [STAT] Statistics in the population multiple linear regression equation that indicate the effect of each independent variable on the dependent variable with the influence of all the remaining variables held constant; each coefficient is the slope between the dependent variable and each of the independent variables. ( 'pärshəl ri'gresh-ən ,kō-ə-fish-ənt )

**partial-select output** [ELECTR] The voltage response produced by applying partial-read or partial-write pulses to an unselected magnetic cell. ( 'pärshəl si'lekt 'aut,pūt )

**partial sum** [MATH] A partial sum of an infinite series is the sum of its first  $n$  terms for some  $n$ . ( 'pärshəl 'səm )

**partial thermoremanent magnetization** [GEOPHYS] The thermoremanent magnetization acquired by cooling in an ambient field over only a restricted temperature interval, as opposed to the entire temperature range from Curie point to room temperature. Abbreviated PTRM. ( 'pärshəl 'thermō'rem-ə-nənt ,mag-nē-təz-ə-shən )

**partial tide** [OCEANogr] One of the harmonic components composing the tide at any point. Also known as tidal component; tidal constituent. ( 'pärshəl 'tid )

**partial tone** See partial. ( 'pärshəl 'tōn )

**participation crude** See buy-back crude. ( pär-tis-pā-shən ,krūd )

**particle** [MECH] See material particle. [PARTIC PHYS] See elementary particle. [PHYS] 1. Any very small part of matter, such as a molecule, atom, or electron. Also known as fundamental particle. 2. Any relatively small subdivision of matter, ranging in diameter from a few angstroms (as with gas molecules) to a few millimeters (as with large raindrops). ( 'pärd-ə-kəl ).

**particle accelerator** [NUCLEO] A device which accelerates electrically charged atomic or subatomic particles, such as electrons, protons, or ions, to high energies. Also known as accelerator; atom smasher. ( 'pärd-ə-kəl ik'sel-ə,rād-ər )

**particle beam** [PHYS] A concentrated, nearly unidirectional flow of particles. ( 'pärd-ə-kəl ,bēm )

**particle board** [MATER] Construction board made with wood particles impregnated with low-molecular-weight resin and then cured. ( 'pärd-ə-kəl ,bōrd )

**particle counting** [ANALY CHEM] Microscopic or photomicrographic technique for the visual counting of the numbers of particles in a known quantity of a solid-liquid suspension. ( 'pärd-ə-kəl ,kawnt-ing )

**particle derivative** [FL MECH] The rate of change of a quantity with respect to time, measured at a point that moves along with a particle of a fluid. ( 'pärd-ə-kəl də'riv-ə-tiv )

**particle detector** [NUCLEO] A device used to indicate the presence of fast-moving charged atomic or nuclear particles by observation of the electrical disturbance created by a particle as it passes through the device. Also known as radiation detector. ( 'pärd-ə-kəl di-tek-tər )

**particle diameter** [GEOL] The diameter of a sedimentary particle considered as a sphere. ( 'pärd-ə-kəl dī-am-əd-ər )

**particle displacement velocimetry** [FL MECH] A method of flow-field measurement in which a two-dimensional sheet of a flow field seeded with fluorescent particles is illuminated by a pulsed laser and particle displacements are recorded by a camera. ( 'pärd-ə-kəl di'plās-mənt ,vel-ə'sim-ə-trē )

**particle distribution function** [STAT MECH] A function whose value is the number of particles per unit volume of phase space. ( 'pärd-ə-kəl ,di-strə'bū-shən ,fən-kshən )

**particle dynamics** [MECH] The study of the dependence of the motion of a single material particle on the external forces acting upon it, particularly electromagnetic and gravitational forces. ( 'pärd-ə-kəl dī-nam-ik-s )

**particle electrophoresis** [PHYS CHEM] Electrophoresis in which the particles undergoing analysis are of sufficient size to be viewed either with the naked eye or with the assistance of an optical microscope. ( 'pärd-ə-kəl i-lek-trō-fə'rē-səs )

**particle emission** [NUC PHYS] The ejection of a particle other than a photon from a nucleus, in contrast to gamma emission. ( 'pärd-ə-kəl i-mish-ən )

**particle energy** [MECH] For a particle in a potential, the sum of the particle's kinetic energy and potential energy. [RELAT] For a relativistic particle the sum of the particle's potential energy, kinetic energy, and rest energy; the last is equal to the product of the particle's rest mass and the square of the speed of light. ( 'pärd-ə-kəl ,en-ərgyē )

**particle horizon** [RELAT] The spatial boundary beyond which, in certain universe models, it is impossible for an observer at a given time to receive a signal. ( 'pärd-ə-kəl hə,riz-ən )

**particle-induced x-ray emission** [ANALY CHEM] A method of trace analysis in which a beam of ions is directed at a thin foil on which the sample to be analyzed has been deposited, and the energy spectrum of the resulting x-rays is measured. ( 'pärd-ə-kəl in'düst 'eks-rā i-mish-ən )

**particle lens** [PHYS] An electric or magnetic field, or a combination thereof, which acts upon an electron beam in a manner analogous to that in which an optical lens acts upon a light beam. ( 'pärd-ə-kəl ,lēnz )

**particle mechanics** [MECH] The study of the motion of a single material particle. ( 'pärd-ə-kəl mi,kan-iks )

**particle multiplet** See isospin multiplet. ( 'pärd-ə-kəl 'məlt-ə-plət )

**particle-oriented paper** [MATER] A chart paper that has a magnetic coating which is produced by combining microscopic magnetic flakes with oil to form droplets and then forming these particles into an emulsion that can be applied to the surface of ordinary bond paper or to a clear plastic substrate; the magnetic field of a small-diameter recording head rotates the magnetic flakes so that they absorb or scatter incident light to give a visible dark trace that can also be read magnetically. ( 'pärd-ə-kəl ,ör-ē-ent-əd 'pär-pər )

**particle physics** [PHYS] The branch of physics concerned with understanding the properties and behavior of elementary particles, especially through study of collisions or decays involving energies of hundreds of megaelectronvolts or more. Also known as high-energy physics. ( 'pärd-ə-kəl ,fiz-iks )

**particle properties** [PARTIC PHYS] The various quantities which characterize the behavior of an elementary particle, such as mass, charge, baryon number, spin, parity, hypercharge, and isospin. ( 'pärd-ə-kəl ,präp-ərd-ēz )

**particle-scattering factor** [ANALY CHEM] Factor in light-scattering equations used to compensate for the loss in scattered light intensity caused by destructive interference during the analysis of macromolecular compounds. ( 'pärd-ə-kəl ,skad-ə-rin ,fak-tər )

**particle size** [GEOL] The general dimensions of the particles or mineral grains in a rock or sediment based on the premise that the particles are spheres; commonly measured by sieving, by calculating settling velocities, or by determining areas of

**solidus curve**

which the various compositions finish freezing on cooling, or begin to melt on heating. { 'säl-äd-əs }

**solidus curve** [PHYS CHEM] A curve on the phase diagram of a system with two components which represents the equilibrium between the liquid phase and the solid phase. { 'säl-äd-əs ,kärv }

**solid-web girder** [CIV ENG] A beam, such as a box girder, having a web consisting of a plate or other solid section but not a lattice. { 'säl-äd [web] 'gärdär }

**solfuction** [GEOL] A rapid soil creep, especially referring to downslope soil movement in periglacial areas. Also known as sludging; soil flow; soil fuction. { 'säl-ä-flek-shän }

**solfuction lobe** [GEOL] An isolated, tongue-shaped feature of the land surface with a steep front and a smooth upper surface formed by more rapid solfuction on certain sections of the slope. Also known as solfuction tongue. { 'säl-ä-flek-shän 'lob }

**solfuction mantle** [GEOL] The locally derived, unsorted material moved downslope by solfuction. Also known as flow earth. { 'säl-ä-flek-shän 'mant-əl }

**solfuction sheet** [GEOL] A broad deposit of a solfuction mantle. { 'säl-ä-flek-shän 'shët }

**solfuction stream** [GEOL] A narrow, streamlike deposit of a solfuction mantle. { 'säl-ä-flek-shän 'sträm }

**solfuction tongue** See solfuction lobe. { 'säl-ä-flek-shän 'täŋ }

**solion** [ELEC] An electrochemical device in which amplification is obtained by controlling and monitoring a reversible electrochemical reaction. { 'säl-i-än }

**soliquid** [PHYS CHEM] A system in which solid particles are dispersed in a liquid. { 'säl'ük-wäd }

**solitary wave** [PHYS] A traveling wave in which a single disturbance is neither preceded by nor followed by other such disturbances, but which does not involve unusually large amplitudes or rapid changes in variables, in contrast to a shock wave. { 'säl-ä-ter-ē 'wäv }

**soliton** [MATH] A solution of a nonlinear differential equation that propagates with a characteristic constant shape. [PHYS] An isolated wave that propagates without dispersing its energy over larger and larger regions of space, and whose nature is such that two such objects emerge unchanged from a collision. { 'säl-ä-tän }

**solodize** [GEOL] To improve a soil by removing alkalies from it. { 'sôl-ä-diz }

**Solod soil** See Soloth soil. { 'sôl-äd ,sôil }

**Solo man** [PALEON] A relative but primitive form of fossil man from Java; this form had a small brain, heavy horizontal browridges, and a massive cranial base. { 'sôl-ô 'man }

**Solomon R unit** [NUCLEO] A unit of radiation dose rate due to x-rays, equal to 2100 roentgens per hour. Also known as R unit. { 'säl-ä-men 'är ,yür-nät }

**Solonchak soil** [GEOL] One of an intrazonal, balmomorphic group of light-colored soils rich in soluble salts. { 'säl-ä-n'chäk ,sôil }

**Solonetz soil** [GEOL] One of an intrazonal group of black alkali soils having a columnar structure. { 'säl-ä-n'nets ,sôil }

**solore** [METEOROL] A cold, night wind of the mountains following the course of the Drome River in southeastern France. { 'sôl-ör }

**Soloth soil** [GEOL] One of an intrazonal halomorphic group of soils formed from saline material; the surface layer is soft and friable, and overlies a light-colored leached horizon which, in turn, overlies a dark horizon. Also known as Solod soil. { 'sôl-ät ,sôil }

**Solpugida** [INV ZOO] The sun spiders, an order of nonvenomous, spiderlike, predatory arachnids having large chelicerae for holding and crushing prey. { 'säl-pü-jid-ə }

**solstice** [ASTRON] The two days (actually, instants) during the year when the earth is so located in its orbit that the inclination (about 23½°) of the polar axis is toward the sun; the days are June 21 for the North Pole and December 22 for the South Pole; because of leap years, the dates vary a little. { 'sälz-tös }

**soltstitial colour** [ASTRON] That great circle of the celestial sphere through the celestial poles and the solstices. { 'sälz'tish-äl kär'lür }

**soltstitial points** [ASTRON] Those points of the ecliptic that are 90° from the equinoxes north or south at which the greatest declination of the sun is reached. { 'sälz'tish-äl pöins }

**soltstitial tidal currents** [OCEANOGR] Tidal currents of es-

pecially large tropic diurnal inequality occurring at the time of solstitial tides. { 'sälz'tish-äl 'tid-äl ,kärtens }

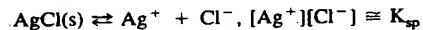
**soltstitial tides** [OCEANOGR] Tides occurring near the times of the solstices, when the tropic range is especially large. { 'sälz'tish-äl 'tidz }

**solvability** [PHYS CHEM] The ability of a substance to form a solution with another substance. { 'säl-yä'bil-äd-ë }

**solvability coefficient** [PHYS CHEM] The volume of a gas that can be dissolved by a unit volume of solvent at a specified pressure and temperature. { 'säl-yä'bil-äd-ë ,kō-pi,fish-änt }

**solvability curve** [PHYS CHEM] A graph showing the concentration of a substance in its saturated solution in a solvent as a function of temperature. { 'säl-yä'bil-äd-ë ,kärv }

**solvability product constant** [PHYS CHEM] A type of simplified equilibrium constant,  $K_{sp}$ , defined for and useful for equilibria between solids and their respective ions in solution; for example, the equilibrium



where  $[\text{Ag}^+]$  and  $[\text{Cl}^-]$  are molar concentrations of silver ions and chloride ions. { 'säl-yä'bil-äd-ë ,präd-äkt ,kän-stänt }

**solvability test** [ANALY CHEM] 1. A test for the degree of solubility of asphalts and other bituminous materials in solvents, such as carbon tetrachloride, carbon disulfide, or petroleum ether. 2. Any test made to show the solubility of one material in another (such as liquid-liquid, solid-liquid, gas-liquid, or solid-solid). { 'säl-yä'bil-äd-ë ,test }

**soluble** [CHEM] Capable of being dissolved. { 'säl-yä-bäl }

**soluble barbital** See sodium barbital. { 'säl-yä-bäl 'bär-bä-täl }

**soluble castor oil** See Turkey red oil. { 'säl-yä-bäl 'käst-är 'öl }

**soluble cutting oil** [MATER] A petroleum oil containing an emulsifying agent to make it mix easily with water; used as a coolant for metal-cutting tools. { 'säl-yä-bäl 'käd-ing 'öl }

**soluble glass** See sodium silicate. { 'säl-yä-bäl 'glas }

**soluble guncotton** See pyroxylin. { 'säl-yä-bäl 'gän,kätn }

**soluble indigo blue** See indigo carmine. { 'säl-yä-bäl 'in-dä-gö 'blü }

**soluble nitrocellulose** See pyroxylin. { 'säl-yä-bäl 'ni-trö 'sel-yä-lös }

**soluble oil** [MATER] An oil that readily forms a stable emulsion or colloidal suspension in water. Also known as emulsifying oil. { 'säl-yä-bäl 'öl }

**soluble starch** [MATER] A group of water-soluble polymers formed from starch, such as the starches derived from corn or potato, by acetylation, acid hydrolysis, chlorination, or by action of enzymes to form starch acetates, ethers, and esters; used as textile sizing agents, emulsifying agents, and paper coatings. { 'säl-yä-bäl 'stärch }

**solum** [GEOL] The upper part of a soil profile, composed of A and B horizons in mature soil. Also known as true soil. { 'sôl-äm }

**solute** [CHEM] The substance dissolved in a solvent. { 'säl-yüt }

**solute compartmentation** [BOT] The sequestering of a plant cell's salt in a vacuole so that the salt does not poison the cell. { 'säl-yüt käm,pärt-mänt-tä-shän }

**solution** [CHEM] A single, homogeneous liquid, solid, or gas phase that is a mixture in which the components (liquid, gas, solid, or combinations thereof) are uniformly distributed throughout the mixture. { 'säl-lü-shän }

**solution ceramic** [ELEC] A nonbrittle, inorganic ceramic insulating coating that can be applied to wires at a low temperature; examples include ceria, chromia, titania, and zirconia. { 'säl-lü-shän säl-ram-ik }

**solution dyeing** [TEXT] Adding dye to the chemical compound in the spinneret before extrusion. Also known as dope dyeing. { 'säl-lü-shän ,döp-ing }

**solution gas** [PETRO ENG] Gaseous reservoir hydrocarbons dissolved in liquid reservoir hydrocarbons because of the prevailing pressures in the reservoir. Also known as dissolved gas. { 'säl-lü-shän ,gas }

**solution gas drive** See internal gas drive. { 'säl-lü-shän ,gas 'driv }

**solution-gas reservoir** [PETRO ENG] Oil reservoir initially at or above the bubble-point pressure of the gas-oil mixture, and produced primarily by the expansion of the oil and its dissolved



Sun spider. (From T. I. Storer and R. L. Usinger, *General Zoology*, 3d ed., McGraw-Hill, 1957)

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eralocorticoids (which affect mineral metabolism), the glucocorticoids (which affect glucose metabolism), the adrenal cortical androgens (which control secondary sex characteristics in males), and the estrogens (estrus-producing hormones).

Secretion of the glucocorticoids is controlled by adrenocorticotropin (ACTH), secreted by the anterior lobe of the pituitary. Secretion of the mineral corticoid is ultimately controlled by the kidney secretion of renin. See ANDROGEN; ESTROGEN; PITUITARY GLAND; STEROID.

[H.Lip.]

Malfunctions of the adrenal glands may be divided into two major categories, those of the medulla and those of the cortex. The principal disorders of the medulla are tumors. One rare type, the pheochromocytoma, is an actively secreting neoplasm which causes excessive production of the medullary hormones, epinephrine and norepinephrine. Other rare, nonsecreting tumors of the medulla are the ganglioneuroma and the highly malignant neuroblastoma of infancy and childhood.

Congenital defects of the adrenal glands are principally those related to the absence of glandular tissue or to the lack of its normal secretory ability (hypoplasia).

The adrenals are susceptible to certain infections, largely because they are so well vascularized. The resulting inflammations may produce acute reactions and crises, or in lesser cases, may eventually cause scarring and other degenerative changes with or without hormonal alteration.

There are many varieties of neoplasms of the adrenal cortex. They may be either primary or metastatic. Either type may cause alterations of adrenal hormone output, and the classification is often based on clinical findings and sometimes on histologic types. Major clinical categories include Cushing's syndrome, the adrenogenital syndrome, feminizing syndromes, hyperaldosteronism, and combinations of components of any or several of these.

The functional types, in which hormone output is altered, are more readily recognized because of the changes they effect. Nonfunctional tumors may be silent and therefore often offer a problem in diagnosis. The most common metastatic malignancies in the adrenals arise from bronchogenic carcinoma, although other carcinomas may also spread to these glands. See ADDISON'S DISEASE.

[E.G.St./N.K.M.]

**Adsorption** The property of an interface between two immiscible phases (solid, liquid, or vapor) to attract and concentrate components of either phase or both phases as an adsorbed interfacial film. Adsorption is a basic thermodynamic property of interfaces, resulting from a discontinuity in intermolecular or interatomic forces. It is also important in nearly all industrial processes and products.

Some definitions that describe adsorption are as follows: The adsorbent is the solid or liquid which adsorbs. The adsorbate is the solid, liquid, or gas which is adsorbed as molecules, atoms, or ions. Physical adsorption or physisorption is reversible adsorption by weak interactions only; no covalent bonds occur between the adsorbent and adsorbate; heats of physical adsorption are usually less than 15–20 kcal/mole (63–84 kilojoules/mole). Chemical adsorption or chemisorption is adsorption involving stronger interaction between adsorbate and adsorbent usually accompanied by rearrangement of atoms within or between adsorbates; reaction occurs between the surface of the adsorbent and the adsorbate; heats of chemisorption are usually in excess of 20–30 kcal/mole (84–126 kilojoules/mole).

Nearly all vapors tend to adsorb onto inorganic solids at temperatures not too much above their boiling point. The intermolecular attractive forces which cause the physical adsorption of vapors are generally dominated by the London dispersion forces, an attraction caused by the perturbation of electron orbits by adjacent atoms. Another attractive force important in vapor adsorption is the interaction of electron-donor (basic)

sites of vapor molecules with electron-acceptor (acidic) sites of adsorbents, or vice versa. These short-range attractions are much stronger than dipole interactions. Silica, an acidic adsorbent, adsorbs basic vapors (water, ammonia, and so forth) much more strongly than acidic vapors (chloroform, CO<sub>2</sub>, NO<sub>2</sub>, and so forth) regardless of the dipole moments.

The adsorption of water is dominated by hydrogen bonding, an intermolecular acid-base interaction onto neutral surfaces such as graphite or polyethylene, except for the acidic or basic sites provided by impurities on these neutral surfaces.

The strong interactions of chemisorption lead to surface compounds with various degrees of covalent bond character. The adsorbed layers are only one molecule thick because covalent bonds exist only between adjacent atoms. Chemisorption occurs on metals and semiconductors and on oxides and sulfides, but is most often observed on transition metals such as silver, nickel, cobalt, platinum, rhodium, and tungsten. Chemisorption is a necessary step in catalysis by these materials. See CHEMICAL DYNAMICS; INTERMOLECULAR FORCES.

Heterogeneous catalysis, in which gas or liquid reactants are specifically adsorbed to a dissimilar phase and chemically altered during their brief retention time, is basic to many industrial processes in the petrochemical, polymer, and chemical industries.

Purification by adsorption is perhaps the oldest known application; examples are wine and beer clarification, color removal in sugar processing, industrial wastewater treatment, and toxic gas adsorption in gas masks.

Adsorption is the basic phenomenon of chromatographic separations, which separate and concentrate components of mixtures according to strength of adsorption onto adsorbents in chromatographic columns.

Adsorption of surface-active substances is the key process in the use of soaps, detergents, emulsifiers, wetting agents, dyes, lubricants, and surface treatments. Other industries dependent on adsorption processes include agriculture, mining, petroleum recovery, papermaking, printing, and photography. See CATALYSIS; CHEMICAL SEPARATION TECHNIQUES; CHROMATOGRAPHY; RESPIRATOR.

[F.M.F.]

**Aegyptopithecus** A primate that lived during Oligocene times, 30,000,000 years ago, in the Egyptian Fayum (see illustration), and is believed to be the common ancestor of humans and apes. The names *Aegyptopithecus zeuxis* and "dawn ape" were given by Elwyn Simons.



Artist's rendering of *Aegyptopithecus*. (Duke University)

*Aegyptopithecus* had an estimated weight ranging from 8 to 12 lb (3.6 to 5.4 kg). The cranial capacity was about 1.8 in.<sup>3</sup> (30 cm<sup>3</sup>) larger than that of any of its mammalian contemporaries, relative to body size. The teeth were equipped for a